

## Tagging of Skipjack in Hawaiian Waters

DANIEL T. YAMASHITA and KENNETH D. WALDRON<sup>1</sup>

THE FISHING of the Hawaiian skipjack (*Katsuwonus pelamis*) though relatively small if compared with the major fisheries of the United States, is the most important commercial fishery in the Hawaiian Islands and the only American fishery exploiting mid-ocean stocks of skipjack. Annual landings average about 11,000,000 pounds with a value to the fishermen of about one and a half million dollars.

The Pacific Oceanic Fishery Investigations (POFI), of the U. S. Fish and Wildlife Service, is engaged in a skipjack tagging program which, it is hoped, will provide information that will increase the effectiveness of the local fishery. Tagging offers a direct means of increasing our knowledge of the growth rates, general migrations, and inter-island movement of the fish. In this report we will describe the type of tags used and the results of our initial studies during the years 1954 to 1956.

A major difficulty in early tuna tagging investigations (Rounsefell and Kask, 1945; Wilson, 1953) was the lack of a suitable tag. Alverson and Chenoweth (1951) contributed to the development of a better tag by their water tunnel experiment to determine the effect of flowing water on various tags attached to frozen albacore (*Germo alalunga*). Following this work, the California Department of Fish and Game developed a tubular plastic tag (Wilson, 1953) and used it extensively for tagging albacore, yellowfin (*Neothunnus macropterus*), and skipjack tuna (Ganssle and Clemens, 1953; Blunt, 1954);

this tag is often called the type G or spaghetti tag.

Prior to announcement of the successful California tag, POFI experimented with several other types, both at sea and in ponds. These tests involved internal tags and external tags of the hook and streamer type. Experiments conducted in 1950 and 1952 were either inconclusive or unpromising, so the California tag (Fig. 1) was adopted for use in Hawaiian waters from 1954 to 1956.

### APPLICATION OF THE TAGS

The type G tag was applied in the manner described by Wilson (1953), with certain modifications. Skipjack were caught by live-bait fishing methods as described by June (1951), with 3 or 4 men in the racks. A skipjack was hooked, swung up, caught by the fisherman, passed to a man designated as "holder," the tag was attached, and the fish was returned to the water. With an experienced crew a skipjack could be tagged and returned to the water in about 20 seconds.

Because it is difficult to handle skipjack without injuring them, various methods including canvas cradles, padded boxes, and electronarcosis were used in attempts to calm the fish. None of these was successful. Since it was deemed necessary to return skipjack to the water as rapidly as possible and since our efforts to quiet the fish were unsuccessful, no attempt was made to measure individual fish. Instead an estimate of the size of skipjack tagged was obtained by measuring fish which were caught and not tagged. Brock (1954) has shown that skipjack school by size, so it was believed that a reliable estimate of the size of tagged fish was obtained in this manner.

<sup>1</sup> Fishery Research Biologists, Pacific Oceanic Fishery Investigations, Honolulu, Hawaii. Manuscript received March 12, 1958.

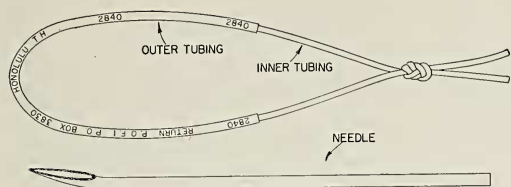


FIG. 1. California type G tag and tagging needle. Legend is on inner tubing only; serial numbers on inner and outer tubing.

Most of the skipjack tagged as described above sounded immediately upon release. On a few occasions they were seen to lead fish from the accompanying school away from the stern of the vessel. While some tagged fish left the school when released, there were indications that others remained in the same school from which they were caught. In one instance a fish released with a white type G tag was observed accompanying the vessel with part of the school for  $4\frac{1}{2}$  hours.

#### RELEASES

Between May, 1954, and July, 1956, 1,961 skipjack were tagged with the California type G tag and released in Hawaiian waters (Fig. 2).<sup>2</sup>

Most of the releases were within the area of the Hawaiian skipjack fishery; a few were released outside this area. This release pattern was followed in order to (1) establish the rate of recovery within the fishery, (2) study the movements of skipjack within the fishery, and (3) ascertain the direction from which skipjack approach Hawaiian waters.

It should be pointed out that the tagged fish were smaller than the usual size (18–22 pounds) composing the season's commercial landings. Eighty-five per cent were 10 pounds or smaller, 14 per cent between 11 and 20 pounds, and only 1 per cent larger than 21 pounds. The small percentage of releases in

<sup>2</sup> In addition, 20 skipjack were tagged with white type G tags and released in the vicinity of the Line Islands, and 12 with blue type G tags northeast of Midway Island.

the larger size categories is due partly to the difficulty in handling these fish, and partly to the general scarcity of large fish when most of our tagging was done.

#### PUBLICITY PROGRAM

Publicity is an important part of most tagging programs, because one way to maximize the returns is to minimize the loss of tags recovered but not noticed by persons unaware of the program. We conducted personal interviews with skipjack fishermen on all islands and distributed posters to major fishing companies, fishing supply centers, and ports throughout the Hawaiian Islands. Fishermen were also informed of our tagging activities through radio broadcasts, transmitted by POFI vessels during their cruises in Hawaiian waters, and through informal letters. Also, wardens of the Hawaiian Division of Fish and Game stationed on the various islands were furnished photographs of tagged skipjack, together with standard recovery information forms. Because of the distinctive appearance of the tag, the publicity program, and the extensive handling of individual fish (when caught, during stowage and unloading of catch, and during butchering at the cannery), the possibility of loss of tags through nonrecognition of tagged fish was considered negligible.

Rewards for the return of tags were not part of the recovery program. Instead we purchased the tagged fish at a price slightly above the market value. A letter giving pertinent information was also sent to the person, or persons, involved in the recovery.

#### RECOVERIES

Of the 1,961 skipjack tagged and released, 9 were recovered by the commercial pole-and-line fishery and 3 from the stomachs of large longline-caught tunas between July, 1955, and February, 1956. The areas of release and recapture for these 12 skipjack are shown in Figure 3 and listed in Table 1. The low rate of recovery, 0.6 per cent, may be attributed in

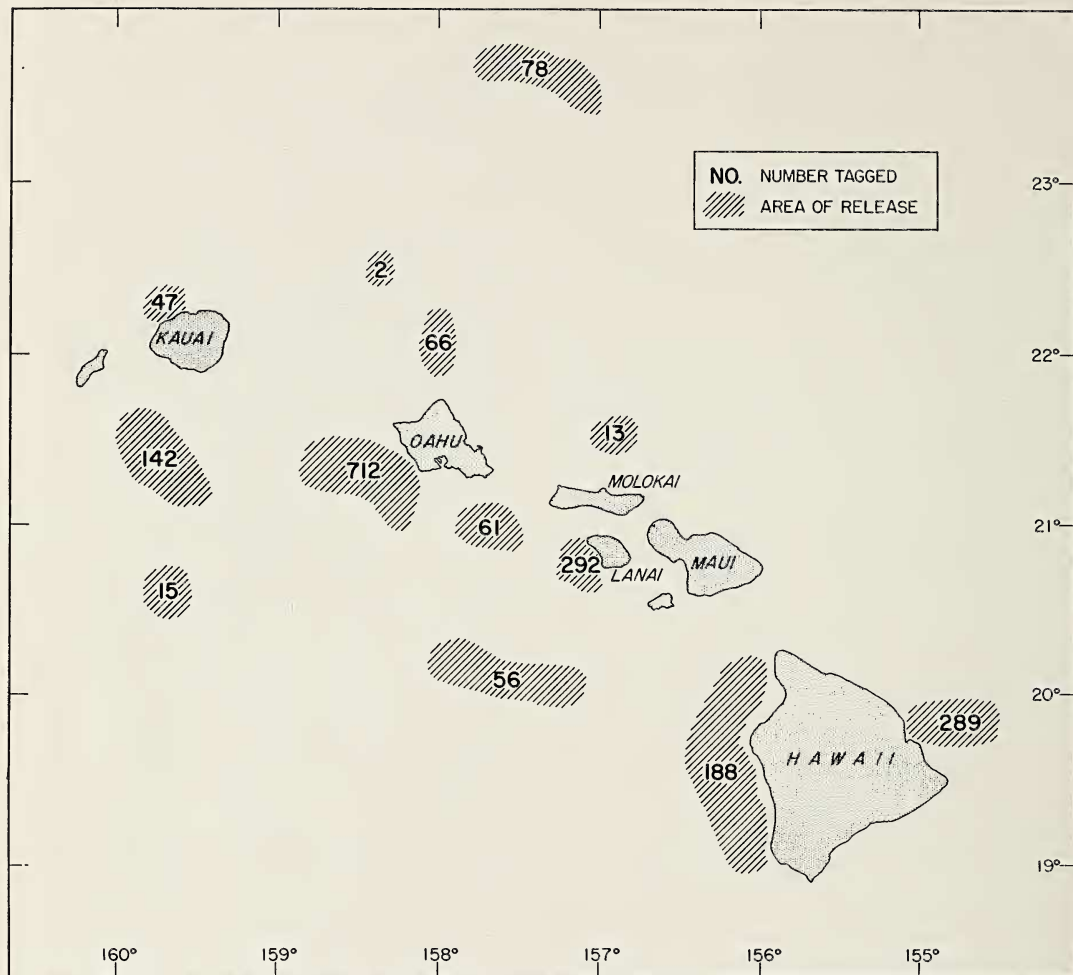


FIG. 2. Skipjack releases in Hawaiian waters, May 1954-July 1956.

part to a combination of the following factors: (1) the initial tagging mortality resulting from handling in the tagging process may have been high; (2) mortality caused by predation of large tunas and spearfishes may have been excessive; and (3) certain groups of tagged skipjack may have moved out of the area covered by the fishery.

*Condition of Tags and Fish:* The condition of the tag and of the skipjack was noted for each of the 9 pole-and-line caught recoveries. One fish, recaptured after only 6 days at liberty, showed quick recuperation. The tag wound

appeared raw and enlarged but there were no signs of infection. Another skipjack, retaken 12 days after tagging, had new skin forming around the edges of the tag wound.

Most of the recovered fish showed a slight chafing of the anterodorsal margin of the caudal fin, caused by the free ends of the tag striking the fin. This could be prevented by trimming the ends of the tag after the knot was tied.

One skipjack recaptured 252 days after release bore only the outer jacket portion of the tag. This protruded from the right side of the fish. The wound on the left side had



TABLE 1  
POFI SKIPJACK RECOVERIES WITH WHITE CALIFORNIA TYPE G TAG

ORDER OF RECOVERY	WEIGHT RANGE OF SCHOOL AT RELEASE	DATE TAGGED	DATE RECOVERED	DAYS OUT	DISTANCE TRAVELED	WEIGHT AT RECOVERY	REMARKS
	Lbs.				Miles	Lbs.	
1	5-10	6/1/55	7/12/55	41	0	3-4	Recaptured from one school
2	6-8	6/8/55	7/12/55	34	0	3-4	
3	3-5	7/20/55	7/26/55	6	40	4	
4	5-8	7/18/55	7/30/55	12	0	6	Found in stomach of long-line-caught 189-lb. yellowfin
5	3-6	8/22/55	8/24/55	2	6	3½	
6	3-5	7/20/55	8/28/55	39	17	4	Tag only found in stomach of longline-caught 190-lb. yellowfin
7	4	8/17/55	8/17-8/26/55	0-9	0(?)	-	
8	3-5	8/25/55	8/25-9/1/55	0-7	0	4	Found in stomach of long-line-caught 209-lb. big-eye
9	4-5	8/8/55	8/29/55	21	14	3	Recaptured from same school
10	4-5	8/8/55	8/29/55	21	14	3	
11	4-5	8/8/55	10/29/55	82	9	4½	
12	5½-9½	5/25/55	2/1/56	252	30	14	

healed completely and was marked only by a black spot on the skin (Fig. 4). Adhesion between the flesh and the plastic held the tag in place.

*Movement:* All of the skipjack recovered were small (3 to 10 lbs.) when tagged. They showed surprisingly little movement, all of them being recaptured within 40 miles of the point of release (Fig. 3 and Table 1). There was no inter-island movement of tagged fish. The probability of recovery of tagged skipjack in offshore waters (beyond 50 miles from land) is low because very little fishing is done in this area. However, each of the main Hawaiian islands has fisheries within 20 miles of shore, so this lack of evidence of inter-island movement cannot be attributed to the distribution of fishing effort.

Two of 39 fish (Table 1, recoveries 9 and 10) released in one group were recaptured 3 weeks later from a single school, indicating that a school of skipjack retains its identity as a unit for some time. Recoveries 3 and 6 tagged on the same day and from the same school, may provide an example of the use-

fulness of this hypothesis. This school may have traveled 63 miles between July 20 and August 28, 1955; 40 miles to where No. 3 was retaken, and 23 miles back to where No. 6 was retaken. Similarly, the group in which recoveries 9, 10, and 11 were released may have traveled a minimum of 37 miles between August 8 and October 29, 1955. These are straight-line distances, and in all likelihood a much greater distance was covered during this period.

*Growth:* Information concerning the rate of growth of skipjack was gained from a tagged fish which weighed 14 pounds when recovered after 252 days (8.4 months) at liberty. Based on the average weight of fish (7 pounds) and the size range of fish (5.5 to 9.5 pounds) in the school at the time of release, a comparison may be made with the growth rates obtained by Brock (1954) in his length frequency studies. If this tagged fish was at the lower end of the size range (i.e., 5.5 pounds) when tagged, it grew at the rate of about 1.0 pound per month. This closely approximates Brock's estimate of 1.2 pounds

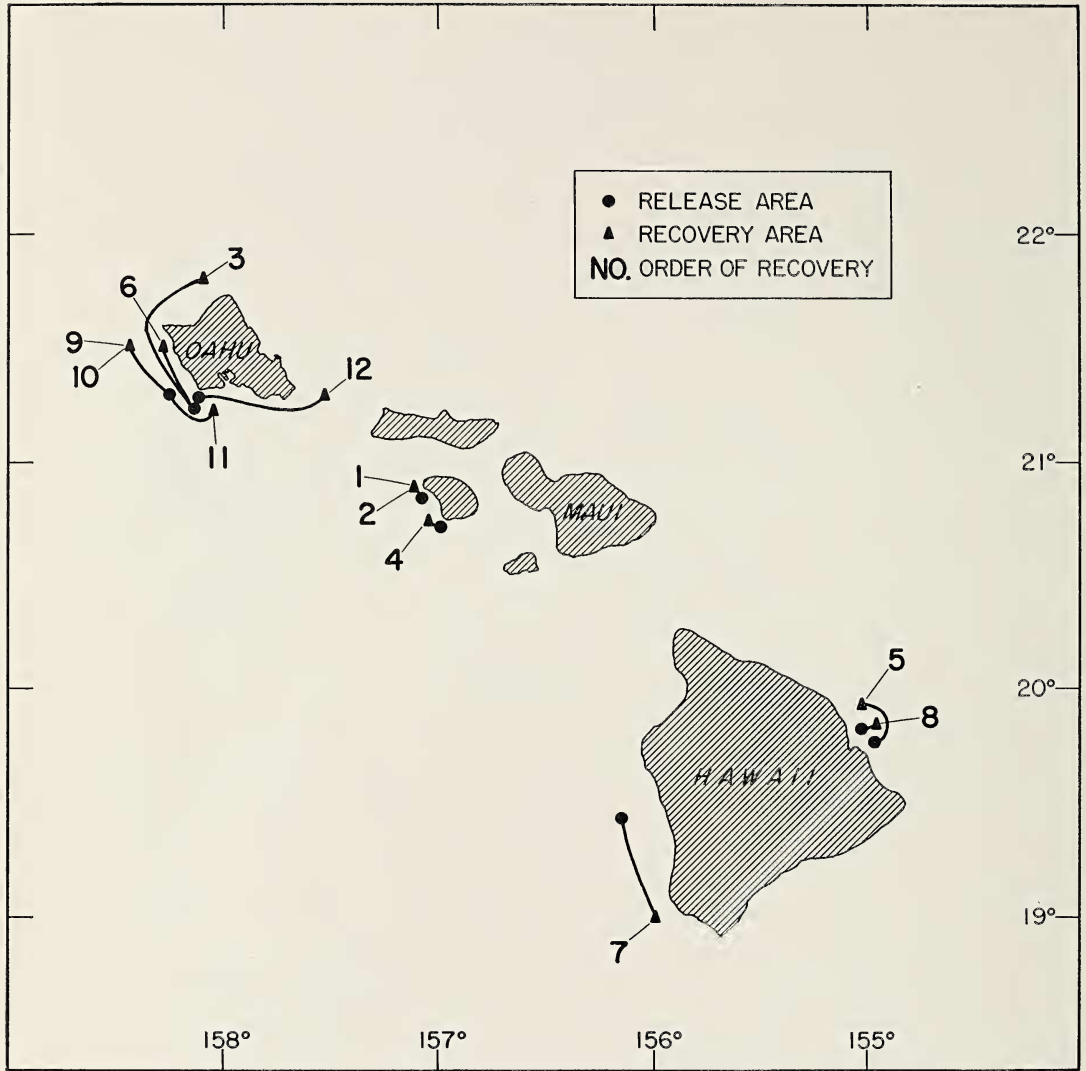


FIG. 3. Skipjack recoveries in Hawaiian waters, July 1955–February 1956.

per month for skipjack of this size (from his fig. 2). If the fish was of average size (i.e., 7 pounds) at the time of release, then a growth of 0.8 pound per month is indicated, which is slightly more than one-half the growth of 1.4 pounds per month shown by Brock. Finally, if the fish was at the upper limit of the size range (i.e., 9.5 pounds), it grew at the rate of 0.5 pound per month, or one-third the rate of growth of 1.5 pounds per month indicated by Brock.

*Predation:* There was evidence that some

loss of tagged skipjack resulted from predation. Two tagged skipjack and one tag were recovered through incidental examination of stomachs of large tuna caught by longline near the island of Hawaii (recoveries 5, 7, 8 in Table 1). All three skipjack weighed about 4 pounds and were recovered within a few days of release. They were the only recoveries of skipjack released in that area.

In order to determine the incidence of skipjack, tagged or untagged, in the stomachs of larger fish, a sampling program at the

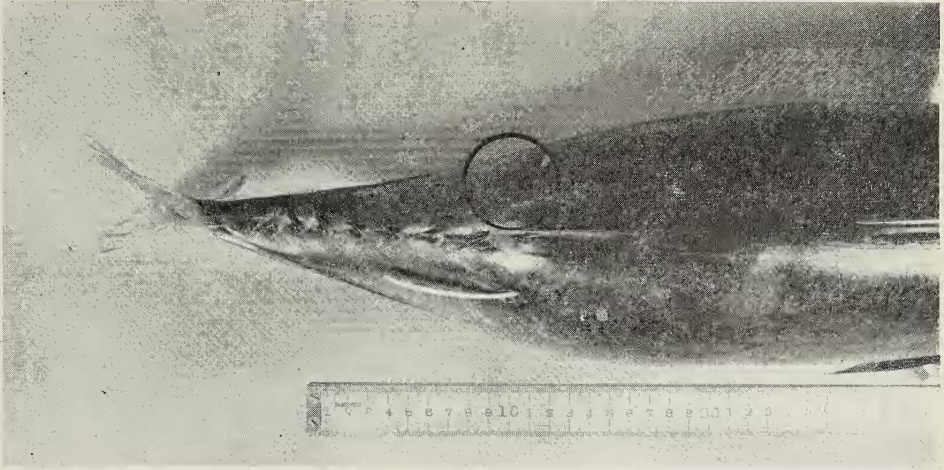


FIG. 4. Tagged skipjack recovered 252 days after release with only the jacket portion of the tag still in place. Dorsal view showing healed wound (dark area in circle) on the left side. Photograph by E. D. Stroup.

Honolulu auction markets was carried out between October, 1955, and June, 1956. During this interval, which included periods when skipjack were being tagged and released within the fishery, stomachs were examined from 538 bigeye (*Parathunnus sibi*), 103 yellowfin, 128 striped marlin (*Makaira audax*), and 74 black marlin (*Makaira ampla*) taken in the Hawaiian longline fishery. Twenty-eight of these stomachs (3.3 per cent) contained a total of 30 skipjack, none of which was tagged. Furthermore, only 9 of the 30 skipjack were as large as those being tagged, i.e., 2 pounds or larger, and the rest were estimated to be 1 pound or less. Only one large skipjack was taken from the stomach of a tuna; the others were from black and striped marlins. Unfortunately, there are no comparable data concerning the number of untagged skipjack from stomachs at the time the three tagged fish were found, but on the basis of subsequent sampling it seems that there was a higher rate of predation on tagged than on untagged fish.

#### SUMMARY

A tagging project was inaugurated to study migrations and to supplement our knowledge

of growth of skipjack in Hawaiian waters.

During the period 1954–1956, California type G tags were attached to 1,961 skipjack released in Hawaiian waters. The majority of these fish weighed less than 10 pounds.

Only 12 or 0.6 percent of these fish were later recovered. This low recovery rate may be attributed to tagging mortality, predation, and movement out of the fishery.

The longest interval between release and recovery, by pole-and-line fishing, was 252 days and the shortest interval was 6 days.

Net movement was limited to 40 miles or less and no inter-island travel was shown.

The tag wounds on recovered skipjack were enlarged but well healed after 12 days. When used on smaller fish, the free ends of the tag caused chafing of the anterodorsal margin of the caudal fin.

One skipjack weighing 14 pounds at recovery grew at an estimated rate of 0.8 pound per month over an 8½-month period.

Predation by large tunas and spearfishes may be greater on tagged than on untagged skipjack. This conclusion is based on the recovery of three tagged skipjack from the stomachs of large tuna.



## REFERENCES

- ALVERSON, D. L., and H. H. CHENOWETH. 1951. Experimental testing of fish tags on albacore in a water tunnel. *Comm. Fish. Rev.* 13(8): 1-7.
- BLUNT, C. E., JR. 1954. Two mid-Pacific recoveries of California-tagged albacore. *Calif. Fish Game* 40(3): 339.
- BROCK, V. E. 1954. Some aspects of the biology of the aku, *Katsuwonus pelamis*, in the Hawaiian Islands. *Pacific Sci.* 8(1): 94-104.
- GANSSE, D., and H. B. CLEMENS. 1953. California-tagged albacore recovered off Japan. *Calif. Fish Game* 39(4): 443.
- JUNE, F. C. 1951. Preliminary fisheries survey of the Hawaiian-Line islands area. Part III. The live-bait skipjack fishery of the Hawaiian Islands. *Comm. Fish. Rev.* 13(2): 1-18.
- ROUNSEFELL, G. A., and J. L. KASK. 1945. How to mark fish. *Trans. Amer. Fish. Soc.* 73 (year 1943): 320-363.
- WILSON, R. C. 1953. Tuna marking, a progress report. *Calif. Fish Game* 39(4): 429-442.